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Simulating the behavior of ballasted flocs in circular lamellar settling tank using computational fluid dynamics (CFD)

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ABSTRACT

The separation process of water treatment such as coagulation/flocculation separates various particle matters from water using specific gravity differences. Among several particle separation technologies, the ballasted flocculation (BF) process has recently been proposed to cope with water quality changes due to climate change. Each technology of the BF process is designed to maximize the particle removal efficiency of the whole process. The removal efficiency of the separation process is affected by not only floc characteristics but also hydraulic characteristics, resulting in the short-circuiting flow, dead-zone due to the density difference formed by temperature and specific gravity of the liquid, and the turbulence caused by the shape of the inlet and outlet. The circular lamellar settling tank can reduce a short-circuiting flow and dead-zone. In addition, it can reduce the settling distance and the settling time of suspended solid, while the increased effective sedimentation area can increase the sedimentation efficiency per unit volume. However, if the lamellar plate is designed improperly, the flocs to be removed inevitably release to effluent or accumulate on the plate, which affects the water quality negatively. Therefore, in this study, to confirm the removal efficiency of ballasted flocs according to the angle of the lamellar plate in a circular lamellar settling tank, we simulate the effect of changing the plate angle using computational fluid dynamics (CFD). CFD simulation was conducted to estimate the particle inflow ratio into the lamellar module, the particle removal efficiency of the lamellar module, and the whole particle removal efficiency of the circular lamellar settling tank. The particle inflow ratio into the lamellar module is the smallest at 60° of lamellar plate, while the specific gravity and the size of particles are smaller. This phenomenon shows that the sedimentation force by gravity is predominant. The particle removal efficiency of the lamellar module was also the highest at 60° of lamellar plate.

Keywords: Ballasted flocculation; Lamellar settling tank; Angle of lamellar plate; Behavior of particles

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